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Design and Simulation of E-shape Fractal Antenna for Multiband Wireless Applications

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Abstract

The proposed E-Shaped fractal Antenna is presented in this paper for Multiband applications in Wireless Communication in the range of C-Band Frequencies. Antenna is an important device for wireless communication because based on this antenna performance to rating the quality of wireless services. In this paper the proposed E-shape fractal antenna designs are present and to study the various effects of different parameters with corresponding to change the patch length,width of the patch, substrate height, and thedielectric constant for wireless applications. The antennas are designed using Advanced Design System (ADS) Software. The antenna parameters like return loss, bandwidth, resonating frequency, directivity, gain are calculated in order to get the best antenna. The proposed E-Shape patch Antenna was designed and which resonates at 4.4GHz, 5.78GHz 7.0GHz, 7.6GHzfrequencies and provide variety of application in wireless communication like WI-FI, WLAN, WIMAX, Remote sensing and RF applications, Radar applications, High frequency satellite application.

Keywords: Multi Band, E-Shape Patch, Advanced Design System

**Reviewed by* ICETSET'16 *organizing committee*

1. Introduction

The Wireless Communication is nothing to transmit and receive the data (or) message over free space that means without using wires (or) electrical conductors. Recently the wireless communication reaches exordinary level of services with reliable efficiency. Mostly the microstrip patch antenna are choose for wireless communication because it have more advantages like low profile light weight, and easy to fabricate.

Nowadays therehave been great deal to design a antenna for wireless communication. Because the antenna can expands the wireless communication range in the level of wide and broad band services. The proposed E-shape fractal antenna is suitable for wide and ultra-frequency bands by using iteration and co-axial feed method

This structure can analysed using different parameters with corresponding resonance frequency [1].The propose E-shape fractal with patch antenna is adapt for LTE,S-band applications, by introducing the fractal geometry the proposed design can achieve the various mobile standards applications [2].The proposed antenna mainly used for c band applications. The C-band frequency Range lies between 3GHz-8GHz.The antenna performance is mainly depends on the feeding methods and its position. Based on this feeding position we can easily to achieve the required applications. Antenna can feed by using various methods. These methods can be classified into two types-conducting and non-conducting. In the conducting method the RF power is fed directly to the radiating patch make use of a connecting element such as a microstrip line.In the non-conducting method, electromagnetic field coupling is successfully completed due tothe power transfer between the microstrip line and the radiating patch. The popular feeding methods are microstrip line feed, coaxial probe (both conducting and non-conducting), aperture coupling, inset feed, and proximity feeding technique for both conducting and non-conducting. To analyse the proposed antenna parameter using microstrip line feed method. The main purpose of the microstrip line feed in the patch is to match the impedance of the feed line and the patch without any additional matching elements. This is achieved by properly controlling the microstrip line feed position. The main advantage this feed method is to ease to fabrication, simple to modelling and good impedance matching. The bandwidth range of this feeding technique in between 2-5%

2.Antenna Design

2.1Rectangular Microstrip Patch Antenna

To design the proposed E-shape antenna can make by using the rectangular patch. Initially the rectangular patch antenna was created and to introduce the slots with corresponding length and width to make the E-shape antenna. To measure the various and different applications by varying the antenna terms like length, width and thickness of the antenna. This structure is designed for UWB application. The proposed E-Shape fractal antenna was designed using FR4 substrate with 1.6 mm and the dielectric constant value is 4.4. The length and width of the antenna can calculate using the mathematical equations.

Step 1: Calculation of Width (W)

For the efficient radiator, practical width that leads to better radiation efficiency is calculated by using transmission line model equation.

$$f0=c/2\sqrt{\varepsilon\ eff\ [(m/L)\ 2 + (n/W)2]} \qquad (1)$$

Step2: Calculation of the effective dielectric constant ($\varepsilon reff$)

The effective dielectric constant is obtained by referring to equation (2)

$$\varepsilon reff= (\varepsilon r+1)/2 + (\varepsilon r-1)/2$$

$$[1+12W/h]½ \qquad (2)$$

Where;

εreffis effective dielectric constant, εrdielectric constant of the substrate is the height of the substrate, W is the width of the patch.

Step 3: Calculation of effective length (Lreff)

The effective length can obtain by using equation(3)

$$LEFF=L +2\Delta L \qquad (3)$$

Step 4: Calculation of Length Extension (ΔL)

The length extension can calculate by using equation (4)

$$\Delta L=0.412h (\varepsilon reff+0.3) [W/h +0.264] / (\varepsilon reff-0.258) [W/h +0.8] \qquad (4)$$

The actual length can obtain by using the equation

Step 5: Calculation of Actual length (L)

$$L =Leff-2L$$

2.2 Geometry Of The E-Shape Patch Design

The Proposed E-shape patch design can make by introducing slot on the rectangular patch antenna with correspondence length and width. The proposed antenna geometry can see below the figure 1.based on this designing parameter the antenna can satisfies the requiredapplications The proposed antenna is resonates at different level of frequency with good return loss and power delivery ratio. Initially the radiated power in the range is 0.00048dbi, the gain value is 4.96dbi, the range of directivity is 11.1dbi, maximum intensity is 0.00050(w/sr) at the resonance of 4.434 GHz with -27.9dbi return loss with 89.56% efficiency. The radiated power range is 0.0004dbi, the gain value is 2.06dbi, the range of directivity is 8.64dbi, maximum intensity is 0.00024(w/sr) at the resonance of 5.787 GHz with -19.16dbi return loss with 88.25% efficiency.

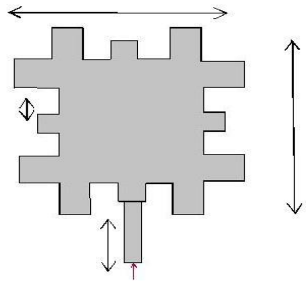


Table 1. Parameters of the proposed antenna

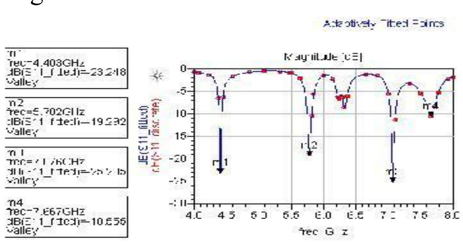
Parameter		Dimension s(mm)
Rectangular patch	Length(L_1)	10
	Width(w_1)	15
Feed line	length(L_f)	2
	width(W_f)	3.8
slot	Length(Ls_1&Ls_2)	7.4,8.4
	Width(W_{s1},2,3,4)	1.0
Substrate thickness(FR4)		1.6

3. Simulated Results And Discussion

To analyse and evaluate the antenna performance via the optimized parameters using ADS software. The simulated antenna results are s11 response, radiation pattern, current distribution, gain, directivity, and efficiency.

3.1 Return Loss

Return loss is the important parameter for to analyse the antenna performance in wireless environment. Because it is used to analyse effective power delivery of the designed antenna. From this result the peoples can easily understand the performance and the designed antenna is suitable for our required services. From this observation there are six resonance frequencies are observed. At 4.434 GHz range the return loss value is - 27.9dbi, At 5.787GHz the value of the return loss is -19.161dbi, At 7.072 GHz the value of the return loss is -23.656dbi, At the resonance frequency range 7.648GHz the return loss value is -10.909dbi.



3.2 Antenna Parameters

The antenna parameters includes radiated power in watts, effective angle (steradian), Directivity(dbi), Gain(dbi), Maximum intensity (watts/steradian), angle of intensity maximum with respect to theta and phi values.

Antenna Parameters

Power radiated (Watts)		0.000484878
Effective angle (Steradians)		0.966922
Directivity(dBi)		11.1382
Gain (dBi)		4.96845
Maximim intensity (Watts/Steradian)		0.000501465
Angle of U Max (theta, phi)	2	126
E(theta) max (mag,phase)	0.363216	37.4294
E(phi) max (mag,phase)	0.495392	-121.763
E(x) max (mag,phase)	0.215506	73.8234
E(y) max (mag,phase)	0.575527	47.7939
E(z) max (mag,phase)	0.012576	-142.571

OK

At 4.43GHz

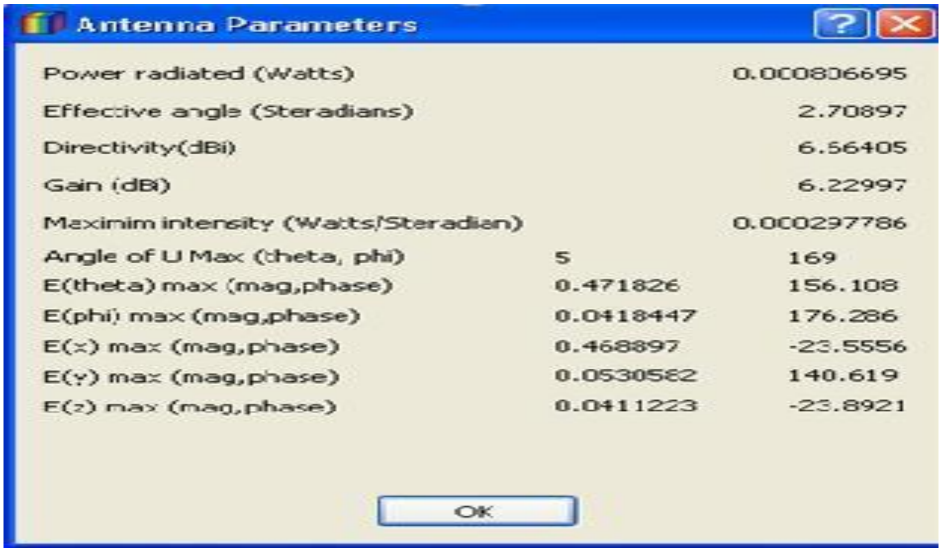
The proposed antenna is resonates at different level of frequency with good return loss and power delivery ratio. Initially the radiated power in the range is 0.00048dbi, the gain value is 4.96dbi, the range of directivity is 11.1dbi, maximum intensity is 0.00050(w/sr) at the resonance of 4.434 GHz with -27.9dbi return loss with 89.56% efficiency. The radiated power range is 0.0004dbi, the gain value is 2.06dbi, the range of directivity is 8.64dbi, maximum intensity is 0.00024(w/sr) at the resonance of 5.787 GHz with -19.16dbi return loss with 88.25% efficiency.

Antenna Parameters

Power radiated (Watts)		0.000414042
Effective angle (Steradians)		1.71623
Directivity(dBi)		8.64129
Gain (dBi)		2.05379
Maximim intensity (Watts/Steradian)		0.000243571
Angle of U Max (theta, phi)	66	341
E(theta) max (mag,phase)	0.422819	36.5437
E(phi) max (mag,phase)	0.0527823	118.437
E(x) max (mag,phase)	0.165904	42.4294
E(y) max (mag,phase)	0.0695521	171.278
E(z) max (mag,phase)	0.386264	-143.456

OK

At 5.78GHz



At 7.6GHz

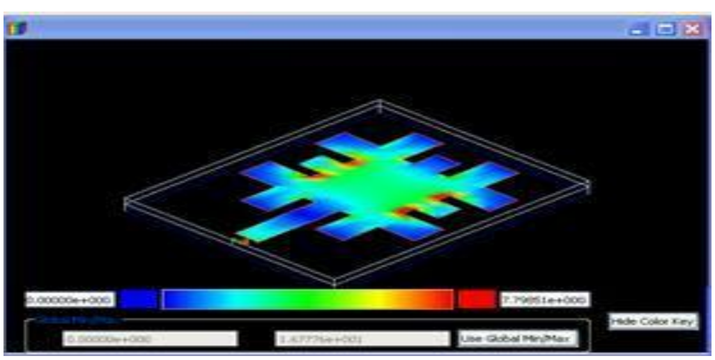
Fig3. Antenna Parameter of the E-shape fractal antenna

The radiated power in the range of 0.00065dbi, the gain value is 5.2dbi, the range of directivity is 9.7, maximum intensity is 0.00050(w/sr) at the resonance of 7.072 GHz with -23.65dbi return loss with 89.64% efficiency .

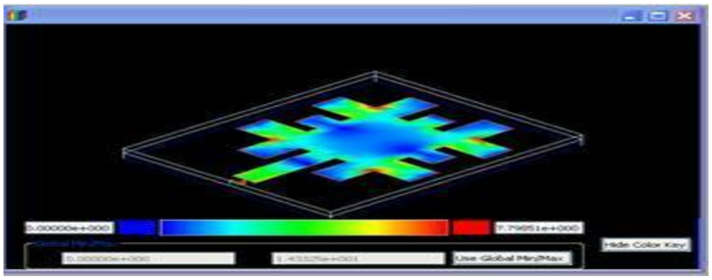
The radiated power in the range of 0.0008dbi, the gain value is 6.22dbi, the range of directivity is 6.6dbi, maximum intensity is 0.00029(w/sr) at the resonance of 7.648 GHz with - 10.9 dbi return loss with 84.79% efficiency.

3.3Current Distribution

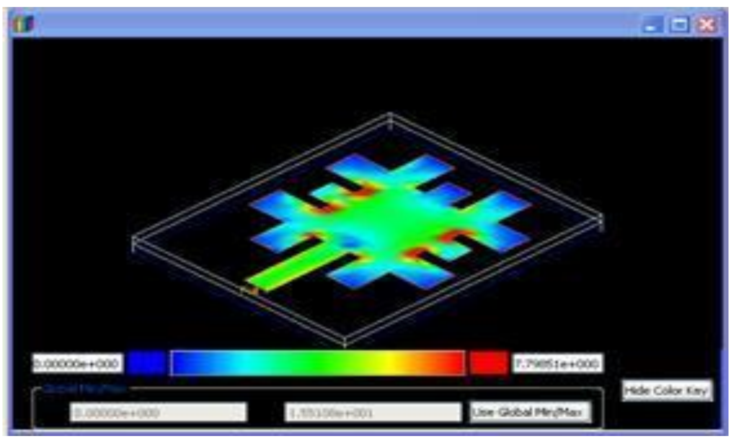
The red colour shows the maximum radiation of the antenna.The current distribution is one of the main parameter to analyse the antenna performance. The current distribution of the start (4.4GHz) and (7.6GHz) ending frequency range is shown in figure 4.



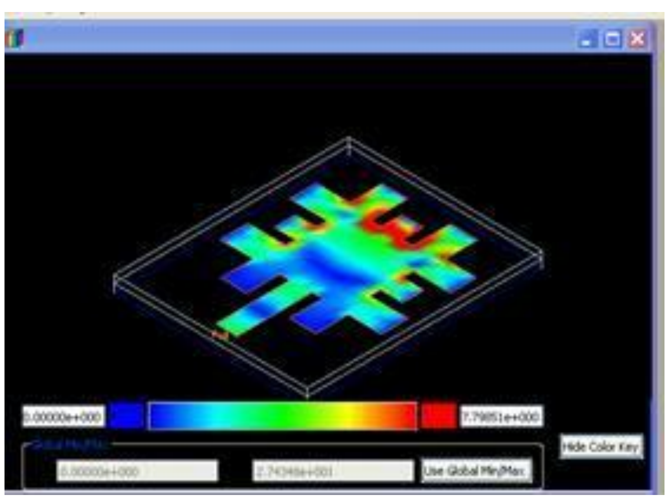
At 4.43GHz



At 5.78 GHz



At 7.072GHz

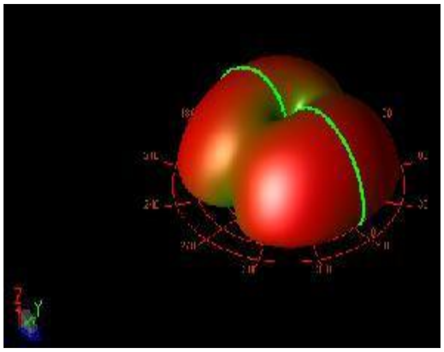


At 7.6GHz

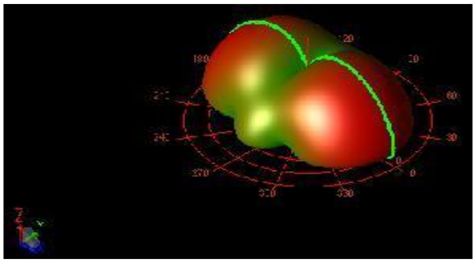
Figure4. Current Distribution of the E-shape fractal antenna

3.4 Radiation Pattern

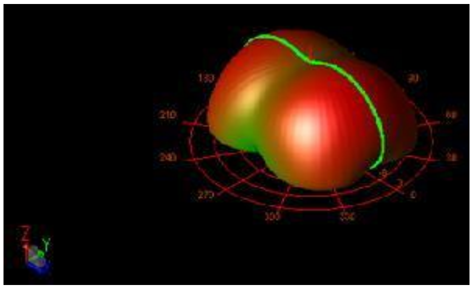
The radiation pattern is important for analyse the variation in the radiatedpower range by an antenna as a function of the direction away from the antenna. The radiation pattern of the proposed antenna can analysed with corresponding resonance frequency.an antenna radiation pattern (or) antenna pattern defined as mathematical and graphical representation of radiation properties of the antenna. The radiation patterns of the proposed E-shape fractal antenna are shown below figure.



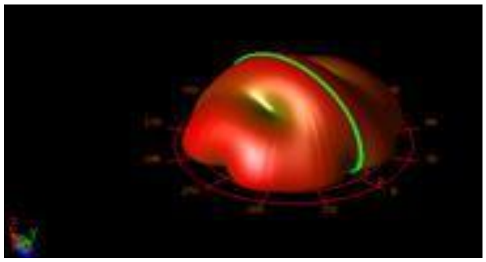
At 4.43GHz



At 5.78 GHz



At 7.072GHz

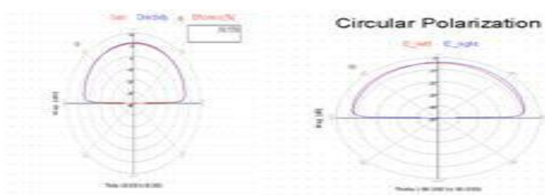


At 7.6GHz

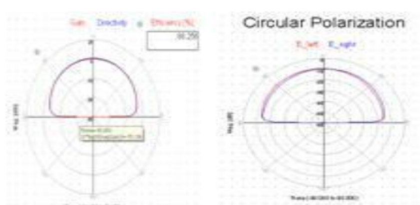
Fig5. Radiation Pattern of the E-shape fractal Antenna

3.5 Circular Polarization And Em Far Field Cut The E-Shape Fractal Antenna

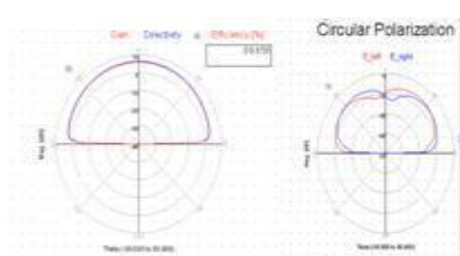
Polarization is the important property of the wavebecause that disrobes the orientation of the oscillation. The circular polarization plot gives that normalised electric field components consist of two orthogonal components.



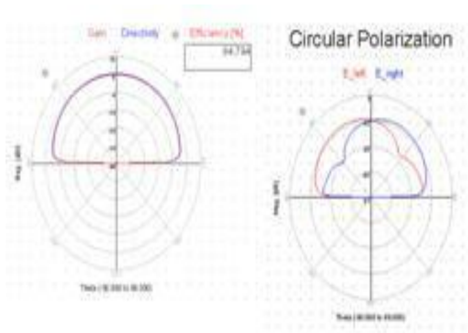
At 4.43GHz



At 5.78 GHz



At 7.072GHz



At 7.

Polarization is the important property of the wavebecause thatdescribes the orientation of the oscillation. The circular polarization graph gives a normalised electric field component that includes two orthogonal components. The circularly polarized microstrip antennas are widely used for mobile communication compare to other types of polarization due to avoid the multipath reflections.The condition of realizing circular polarization on a proposed E-shape fractal antenna is by inspiring two linear polarization directions and had the same amplitude and the phase difference is 90˚. Differentfeeding methods are used to realize the circular polarization. The single microstrip line feed is used for E-shape fractal antenna for multiband wireless application.Corresponding to different resonance frequency the resulting wave can have angular variation.

3.4 Radiation Characteristics Of The E-Shape Fractalantenna

Frequency (GHz)	4.434	5.787	7.072	7.648
Gain (dbi)	4.96	2.06	5.23	6.22
Directivity(dbi)	11.1	8.64	9.76	6.6
Return loss (dbi)	-27.9	-19.16	-23.6	-10.90
Efficiency (%)	89.56	88.25	89.65	84.79
Applications	WIMAX,WI-FI	WIFI, WLAN	Remote sensing, Rador applicaions	High frequency satellite applications

Table 2. Radiation characteristics of the E-shape patch antenna

4. Conclusion

The proposed E-shape patch antenna is design and simulated using ADS Software. From the analysis of the proposed antenna result this structure is very suitable for C-band applications.The proposed E-Shape patch Antenna was designed and which resonates at 4.4GHz, 5.78GHz 7.0GHz,7.6GHzfrequencies and provide variety of application in wireless communication like WI-FI, WLAN, WIMAX, Remote sensing and RF applications, Radar applications, High frequency satellite application.

5.Future Work

To Introduce the fractal on the E-shape patch for enhancement the gain and bandwidth, and compare the fractal antenna parameters with different feed line results using ADS software.

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